AWIN Alerting Task

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The Evolution of AWIN Systems

- **Pre-AWIN Problems**
  - Preflight information gets old
  - In-Flight aural information is
    - Unavailable for reference OR requires attention to write down
    - Requires mental workload to develop spatial representation
    - Requires attention and ATC frequency switch to access
    - Difficult to obtain, especially when things get bad

- **1st Generation AWINs**
  - Give pilots their own ***"weather channel in the cockpit"***
  - Facilitate access and provide weather information

- **2nd Generation AWINs**
  - Relieve pilots from monitoring the "weather channel"
  - Know where weather-of-concern is, implications, & guidance.

Smart Alerting

Situation Awareness (SA)

(Endsley, 1988)

Level 1 - ***perceiving critical factors*** in the environment

Level 2 - **understanding** what those factors mean, particularly when ***integrated in relation to goals***

Level 3 - understanding what will happen in the ***future***

2nd Generation AWINs

- **Ensure SA Level 1 updates, with minimal workload**
  - Draw attention to changes, recalibrate the mental model
  - Reduce tunnel vision & relieve requirement for sustained attention

- **Improve SA Levels 2 & 3**
  - Integrate information ~ Are they meaningful changes?
  - Extrapolate ~ Dynamics, How's it changing? Impact on future?

- **Encourage Appropriate Action**
  - Guidance & Tools for action selection

Something important changed!
Here's where / what it affects,
.. and help for what to do about it.

Designing for 2nd Generation AWINs

Decisions to support -> Information requirements

Pre-flight "picture"

In-flight Assessment

Identifying hazards

What's changed? Is it meaningful?

Detect alert condition

Communicate to pilot – Design intervention

Attention Direction to Change

Phenomenon & Change History

Implications of Change

Guidance for Action

…. Monitor for consequences of new action….

Decisions & Information Requirements

Take-off & Climb

- Departure direction (headwind, crosswind components)
- **Departure rules** (ceiling & visibility)
- Runway selection (runway conditions)
- Climb performance (density altitude)
- Local area hazard avoidance

Enroute

- **Flight rules selection/change (VFR/ IMC)** (ceiling, visibility)
- **Weather hazards intersecting route** (turb, convective, icing, local winds)
- Fuel consumption & altitude selection (winds)
- Aircraft Performance (turbulence, volcanic ash, icing)

Arrival and Descent

- Approach direction (headwind, crosswind components)
- **Approach rules** (ceiling & visibility)
- Runway selection (runway conditions)
- Climb performance for missed approach (density altitude)
- Local area hazard avoidance

Landing

- Approach direction (headwind, crosswind components)
- Runway selection (runway conditions)

Information Sources – Assessing Conditions

Weather

- **P 12, 24-hour surface obs/diagnostics**
- **P METARs, TAFs, SIGMETs, AIRMETs**
- **P NEXRAD radar image**
- **i UAT - NEXRAD image**
- **i UAT - METARs**
- **i UAT - TAFs**
- SIGMETS / AIRMETS **(soon)**
- Winds & Temperatures Aloft **(soon)**
- PIREPS
- Echo Tops
- Digital ATIS
- Composite Moisture Stability
- US Low Level WX 00Z, 12Z
- Local NEXRAD
- Visible/Infrared Satellite
- AWOS/ASOS
- Ownship sensors
  - icing, pressure, temp, TAMDAR (soon)
- New products (C/FIP, CCFP, ….)

Reference Sources

- **FAA Regulations & Guidance**
  - **FARs**
  - **Aeronautical Information Manual**
  - Published approaches …
- **Pilot preferences**
- **Aircraft characteristics**
  - Pilot Operating Handbook
- **Infrastructure capabilities**
  - Airport Facilities Directory
- **Terrain**
  - GIS
- **Airspace**
- ***Traffic***

Identifying Alert Conditions – Thresholds

- **FAA Regulations & Guidance**
  - Flight rules (VFR, MVFR, IFR, LIFR)
  - Weather avoidance guidance (AIM)

- **Aircraft Performance Limits**
  - Climb: speed, rate, fuel burn rate
  - Cruise: speed, fuel burn rate
  - Descent: speed, fuel burn rate
  - Operating ceiling
  - Fuel capacity
  - Glide distance
  - Max crosswind component

- **Pilot Preferences**
  - maximum cross-winds on landing
  - minimum decision height/ MDA
  - minimum RVR
  - minimum visibility
  - minimum ceiling
  - distance from moderate convective regions
  - IFR certified & current

Defining Levels of Hazard

- **Relevant** Geospatial Location
  - Origin, Alternates, Destination (+/- XXnm radially)
  - Route (+/- YYnm, ZZ000 ft.)
- **Consequence**
  - Exceeds a safety-of-flight threshold for
    - Airplane (structural), Pilot (self-limits, VFR/IFR, visibility), Mission (fuel, day/night)
- **Imminence**
  - Hazard encounter is certain, unless action taken immediately
- **Surprisal** (for relevant areas)
  - Spatial location (actual or forecasted) deviation
  - Intensity level (actual or forecasted) deviation
- **Graded Alert Levels**
  - If (**Relevant** AND ((**Consequence** OR **Imminence** OR **Surprisal**) is HIGH) → ALERT
  - ***Graded Thresholds -> Fuzzy Alerts***
- **"False Alarms"**

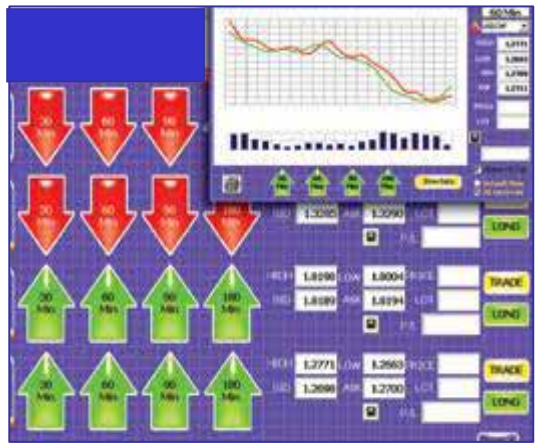
Attention Directing

- **Exogenous Attention Capture "reorienting"**
  - Sound (Nissen 1974; Posner *et al.*1976; Stanton 1992)
  - Abrupt changes in stimulus attributes
    - motion transients (e.g., Thorton & Fernandez-Duque, 2000)
    - luminance (*e.g*. Muller & Rabbit 1989; Posner 1980);
  - *Operator expectations & perceptual characteristics*

- **Design Interventions**
  - Auditory Alarms
  - **Pop-up windows with acknowledgment**
  - Flashing
  - **Highlighting**

Phenomena & Change History

- **Deviations from Expectations**
  - Changes since preflight information
  - **Diverging observations & forecasts**



- **Conveying dynamics**

- **Design Interventions**
  - **Graphical representations of trends**
    - Process control-type charting,
    - **Indications of direction-of-change**
    - Animation: *e.g., NEXRAD (Chamberlain & Lemos, 2005, 2006)*
  - **Referenceable, Sortable "Change Notices" page**

Provide Guidance & Tools for Action

- **Min workload to determine / select best action**

- **Design Interventions**

Guidance

- **Flight path guidance** – ***this*** part of the path is affected
- Mission guidance – fuel, **alternates/destinations** affected
- Recommend alternate sources *(McAdaraugh et al. 2003)*

Tools

- **Rerouting** design & test “avoid alert areas,” for me, for this aircraft
- Alternate selection tool (mission objectives, preferences)
- Smart checklists with aircraft sensing
- Smart communications tuning

So Far….

- **UAT Data collection**
  - Jamestown Williamsburg Airport

- **Prototyping Alert Conditions with GUI**
  - Pre-flight data ingested for in-flight use
  - Suitability of origin, alternates & destinations
    - Ceiling & visibility trending
    - Preflight TAF / Inflight METAR comparison
  - Interface interventions
    - Pop-up windows,
    - Highlighting,
    - Direction of changes,
    - Change notice table

Alerts to Support WX Decision-Making….

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- Departure direction (headwind, crosswind components)
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…. and to use WX Information Appropriately

- **Information reliability**
  - Age of information
  - **Signature idiosyncrasies of weather products/sensor reports**
  - Weather updates not received
  - Software updates not received

- **System integrity alerts**
  - Weather display & information integration device (s/w updates)
  - Ownship sensors (TAMDAR-component reports, etc.)
  - Remote-ship sensors (TAMDAR-component reports)
  - **Ground-based sensors**
  - Satellite coverage
  - Datalink
  - Radio congestion, inaccessibility


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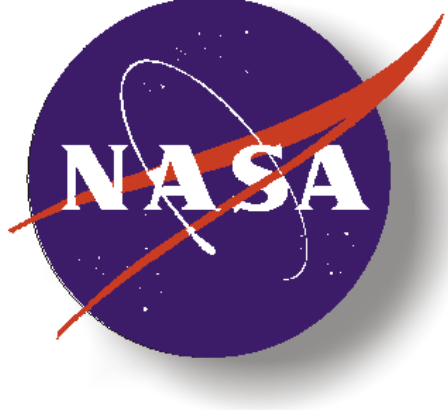
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Questions?